TEXAS INSTRUMENTS

eZ430-RF2500 Development Tool

User's Guide

SLAU227
2007 Mixed Signal Products

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If You Need Assistance

Support for the MSP430 device and the eZ430-RF2500 is provided by the Texas Instruments Product Information Center (PIC). Contact information for the PIC can be found on the TI web site at www.ti.com. Additional device-specific information can be found on the MSP430 web site at www.ti.com/msp430 and www.ti.com/ez430-rf.

Note: IAR Embedded Workbench Kickstart is supported by Texas Instruments

Although IAR Embedded Workbench Kickstart is a product of IAR, Texas Instruments provides support for Kickstart. Therefore, please do not request support for Kickstart from IAR. Please consult all provided documentation with Kickstart before requesting assistance.

We Would Like to Hear from You

If you have any comments, feedbacks, or suggestions, please let us know by contacting us at support@ti.com.

Contents

eZ430-RF2500 Development Tool 1

1. eZ430-RF2500 Overview. Wireless Made Easy. 2

2. Kit Contents, eZ430-RF2500 3

3. Developing with eZ430-RF2500T Target Board 4

4. Specifications 5

5. Supported Devices 6

6. MSP430 Application UART 6

7. Software Installation 7

8. Hardware Installation 7

9. SimpliciTI™ 8

10. Demo – MSP430 Sensor Monitor 8

    10.1. Demo Hardware Setup 9

    10.2. Demo Firmware Download 9

    10.3. Demo Software GUI Setup 10

    10.4. Demo Options 10

11. Suggested Reading 10

12. Frequently Asked Questions (FAQ) 11

13. eZ430-RF2500 Schematics 12

14. Detailed Hardware Install Guide 16

1. eZ430-RF2500 Overview. Wireless Made Easy.

The eZ430-RF2500 is a complete USB-based MSP430 wireless development tool providing all the hardware and software to evaluate the MSP430F2274 microcontroller and CC2500 2.4GHz wireless transceiver.

The eZ430-RF2500 uses the IAR Embedded Workbench Integrated Development Environment (IDE) or Code Composer Essentials (CCE) to write, download, and debug your application. The debugger is unobtrusive allowing the user to run an application at full speed with both hardware breakpoints and single stepping available while consuming no extra hardware resources.

The eZ430-RF2500T target board is an out-of-the box wireless system that may be used with the USB debugging interface, as a stand-alone system with or without external sensors, or may be incorporated into an existing design.

The new USB debugging interface enables eZ430-RF2500 to remotely send and receive data from your PC using the MSP430 Application UART.

eZ430-RF2500 features:

- USB debugging and programming interface featuring a driverless installation and application backchannel
- 21 available development pins
- Highly integrated, ultra-low-power MSP430 MCU with 16MHz performance
- Two general-purpose digital I/O pins connected to green and red LEDs for visual feedback
- Interruptible push button for user feedback
- Range up to 450ft at 10kbps

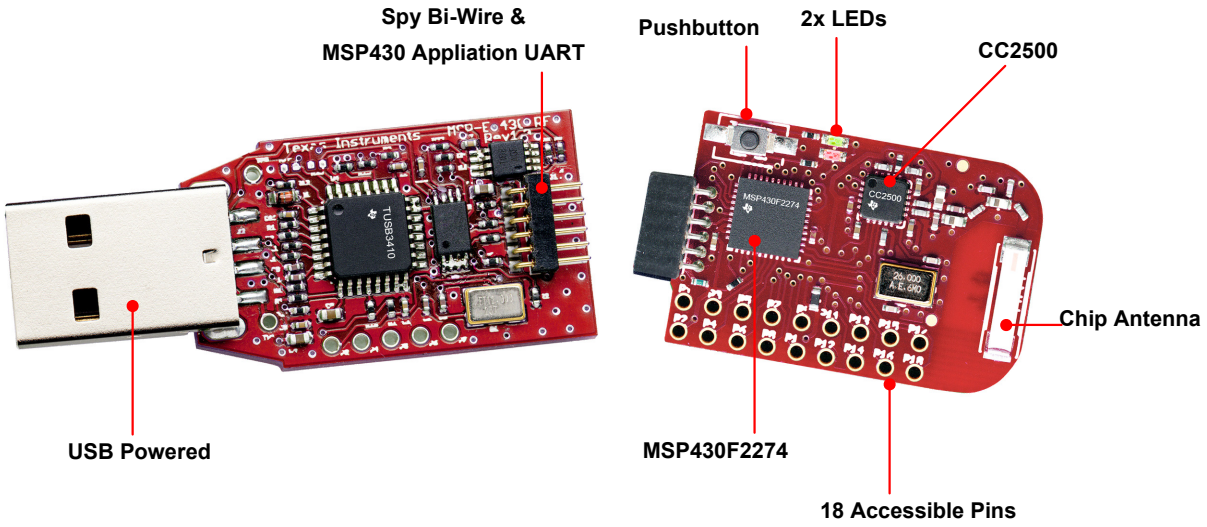


Figure 1. eZ430-RF2500

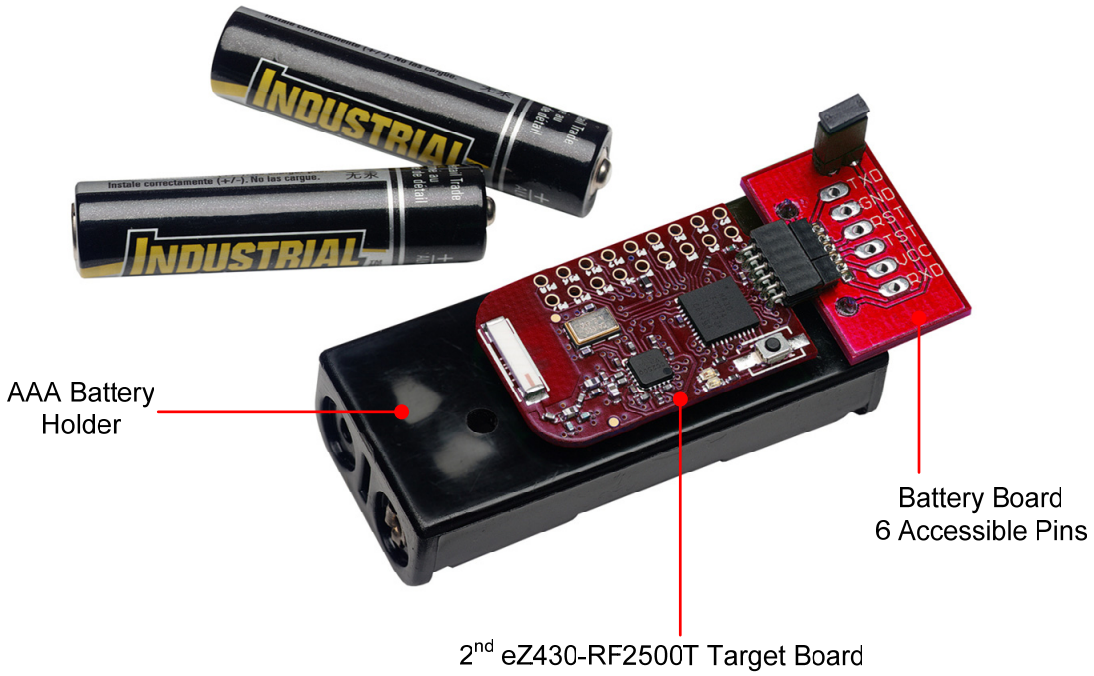


Figure 2. eZ430-RF2500 Battery Board

2. Kit Contents, eZ430-RF2500

- The hardware includes:
  - 2 eZ430-RF2500T target boards
  - 1 eZ430-RF USB debugging interface
  - 1 AAA battery pack with expansion board (batteries included)
- One MSP430 Development Tool CD-ROM containing documentation and new development software for eZ430-RF2500.
  - MSP430F2xx Family User's Guide, SLAU144
  - MSP-FET430 FLASH Emulation Tool User's Guide, SLAU138
  - eZ430-RF2500 User's Guide, SLAU227
  - Code Composer Essentials (CCE), SLAC063
  - IAR Embedded Workbench (Kickstart Version), SLAC050
  - eZ430-RF2500 Sensor Monitor (Code and Visualizer), SLAC139

NOTE: Please visit Texas Instrument's website for latest versions
www.ti.com/msp430

3. Developing with eZ430-RF2500T Target Board

The eZ430-RF2500 can be used as a stand-alone development tool. Additionally, the eZ430-RF2500T target board may also be detached from the debugging interface and integrated into another design by removing the plastic enclosure. The target board features a MSP430F2274 and most of its pins are easily accessible. The following pins are:

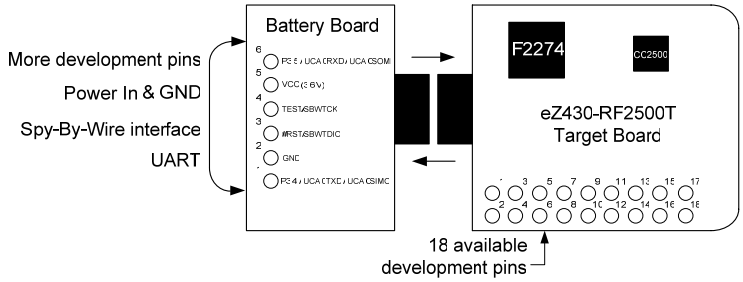


Figure 3. eZ430-RF2500 Development Tool

eZ430-RF2500T target board pin-outs:

Pin	Function	Description
1	GND	Ground Reference
2	VCC	Supply Voltage
3	P2.0 / ACLK / A0 / OA0I0	General-purpose digital I/O pin / ACLK output / ADC10, analog input A0
4	P2.1 / TAINCLK / SMCLK / A1 / OA0O	General-purpose digital I/O pin / ADC10, analog input A1 Timer_A, clock signal at INCLK, SMCLK signal output
5	P2.2 / TA 0 / A2 / OA0I1	General-purpose digital I/O pin / ADC10, analog input A2 Timer_A, capture: CCI0B input/BSL receive, compare: OUT0 output
6	P2.3 / TA 1 / A3 / VREF − / VeREF − / OA1I1 / OA1O	General-purpose digital I/O pin / Timer_A, capture: CCI1B input, compare: OUT1 output / ADC10, analog input A3 / negative reference voltage output/input
7	P2.4 / TA 2 / A4 / VREF + / VeREF + / OA1I0	General-purpose digital I/O pin / Timer_A, compare: OUT2 output / ADC10, analog input A4 / positive reference voltage output/input
8	P4.3 / TB0 / A12 / OA0O	General-purpose digital I/O pin / ADC10 analog input A12 / Timer_B, capture: CCI0B input, compare: OUT0 output
9	P4.4 / TB1 / A13 / OA1O	General-purpose digital I/O pin / ADC10 analog input A13 / Timer_B, capture: CCI1B input, compare: OUT1 output
10	P4.5 / TB2 / A14 / OA0I3	General-purpose digital I/O pin / ADC10 analog input A14 / Timer_B, compare: OUT2 output
11	P4.6 / TBOUTH / A15 / OA1I3	General-purpose digital I/O pin / ADC10 analog input A15 / Timer_B, switch all TB0 to TB3 outputs to high impedance
12	GND	Ground Reference
13	P2.6 / XIN (GDO0)	General-purpose digital I/O pin / Input terminal of crystal oscillator
14	P2.7 / XOUT (GDO2)	General-purpose digital I/O pin / Output terminal of crystal oscillator
15	P3.2 / UCB 0SOMI / UCB 0SCL	General-purpose digital I/O pin USCI_B0 slave out/master in in SPI mode, SCL I2C clock in I2C mode
16	P3.3 / UCB 0CLK / UCA 0STE	General-purpose digital I/O pin USCI_B0 clock input/output / USCI_A0 slave transmit enable
17	P3.0 / UCB 0STE / UCA 0CLK / A5	General-purpose digital I/O pin / USCI_B0 slave transmit enable / USCI_A0 clock input/output / ADC10, analog input A5
18	P3.1 / UCB 0SIMO / UCB 0SDA	General-purpose digital I/O pin / USCI_B0 slave in/master out in SPI mode, SDA I2C data in I2C mode

*pins 13 -18 may be used to test the connection between the F2274 & CC2500

Battery Board pin-outs:

Pin	Function	Description
1	P3.4 / UCA 0TXD / UCA 0SIMO	General-purpose digital I/O pin / USCI_A0 transmit data output in UART mode (UART communication from 2274 to PC), slave in/master out in SPI mode
2	GND	Ground Reference
3	TEST/SBWTCK	Selects test mode for JTAG pins on Port1. The device protection fuse is connected to TEST. Spy-Bi-Wire test clock input during programming and test
4	#RST/SBWTDIO	Reset or nonmaskable interrupt input. Spy-Bi-Wire test data input/output during programming and test
5	VCC (3.6V)	Supply Voltage
6	P3.5 / UCA 0RXD / UCA 0SOMI	General-purpose digital I/O pin / USCI_A0 receive data input in UART mode (UART communication from 2274 to PC), slave out/master in in SPI mode

4. Specifications

MSP430F2274

- 16-MIPS performance
- 200ksps 10-bit SAR ADC
- 2 built-in Op-Amps
- Watchdog timer, 16-bit Timer_A3 and B3
- USCI module supporting UART/LIN, (2) SPI, I2C, or IrDA
- Five low power modes drawing as little as 700nA in standby

PARAMETER	MIN	TYP	MAX	UNIT
OPERATING CONDITIONS:				
Operating supply voltage	1.8		3.6	V
Operating free-air temperature range	-40		85	˚C
CURRENT CONSUMPTION				
Active Mode at 1Mhz, 2.2V		270	390	µA
Standby Mode		0.7	1.4	µA
Off Mode with RAM Retention		0.1	0.5	µA
OPERATING FREQUENCY				
$V_{cc} \geq 3.3V$			16	MHz

CC2500

- 2.4GHz RF Transceiver
- Programmable data rate up to 500kbps
- Low current consumption

PARAMETER	MIN	TYP	MAX	UNIT	CONDITION
OPERATING CONDITIONS:					
Operating supply voltage	1.8		3.6	V	
CURRENT CONSUMPTION					
RX input signal at the sensitivity limit, 250 kbps		16.6		mA	Optimized current
		18.8		mA	Optimized sensitivity
RX input signal 30 dB above the sensitivity limit, 250 kbps		13.3		mA	Optimized current
		15.7		mA	Optimized sensitivity
Current consumption TX (0 dBm)		21.2		mA	
Current consumption TX (-12 dBm)		11.1		mA	
RF CHARACTERISTICS					
Frequency range	2400		2483.5	MHz	
Data rate (programmable)	1.2		500	kbps	
Output power (programmable)	-30		0	dBm	
Sensitivity, 10 kbps		-99		dBm	Optimized current, 2-FSK, 230 kHz RX filter bandwidth, 1% PER
		-101		dBm	Optimized sensitivity
Sensitivity, 250 kbps		-87		dBm	Optimized current, 500 kHz RX filter bandwidth, 1% PER
		-89		dBm	Optimized sensitivity

5. Supported Devices

The eZ430-RF USB debugging interface may be used as a standard Flash Emulation Tool through its Spy-Bi-Wire interface. The eZ430-RF USB debugging interface supports the following MSP430 families:

- MSP430F20xx
- MSP430F22xx

The connector on the USB debugging interface is backward compatible with the eZ430-F2013 and T2012 target boards.

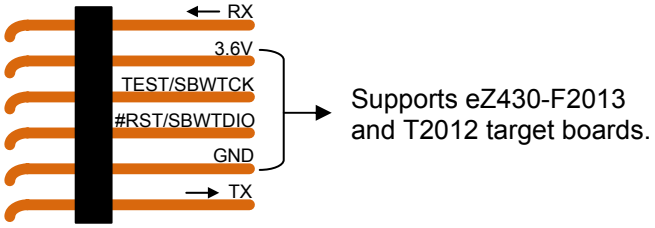


Figure 4. eZ430-RF2500 USB Debugging Interface 6-pin male header

6. MSP430 Application UART

The eZ430-RF USB debugging interface features a back channel MSP430 Application UART that may be used independently of a debug session. This allows the user to transfer serial data to a terminal window at a fixed rate of **9600bps** with **No flow control**. See Figure 5 for typical settings.

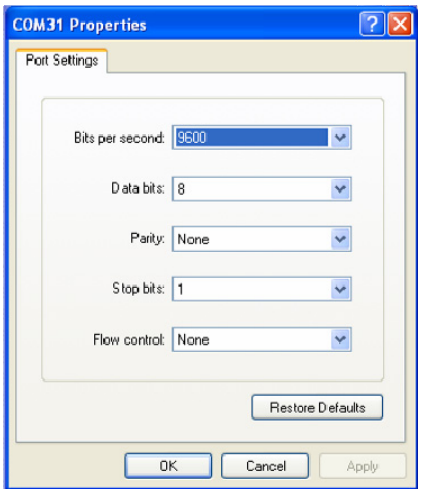


Figure 5. 9600bps with No flow control.

Check the Device Manager for COM-port assignment of the MSP430 Application UART. See Hardware Install Guide Section 14 for more details.

7. Software Installation

The CD-ROM includes 2 different development software tools for the MSP430 which includes IAR Embedded Workbench Kickstart and Code Composer Essentials (CCE). The term “Kickstart” refers to the limited version of Embedded Workbench which allows up to 4kb of C-code compilation. The included CCE is also limited but allows up to 8kb of code compilation. The full version of CCE Pro offers unlimited code compilation which can be purchased from www.ti.com/msp430.

1. Insert the eZ430-RF2500 CD-ROM into your computer. The eZ430-RF2500 start page should automatically display. If not, you can also use a browser to open “index.htm” that is located in the root directory of the eZ430-RF2500 CD-ROM.

   The eZ430-RF2500 is compatible with Windows 2000, and XP.

2. Select **Software → IAR Workbench Kickstart** / **Code Composer Essentials** and follow the instructions.

3. Respond to the prompts to install the software. The installation procedure will install the IDE and TI files. Finish the installation.

8. Hardware Installation

1. Insert the eZ430-RF into USB port. The debugging interface will automatically install itself.

2. (Optional) When prompted for the software for the MSP430 Application UART, allow Windows to “**Install the software automatically**.” This is only possible if IAR Kickstart R4.64 or higher has already been installed.

For more detailed information see **Section 14: Detailed Hardware Install Guide.**

9. SimpliciTI™

SimpliciTI™ is a simple low-power RF network protocol aimed at small RF networks and may be used as a starting point to for your wireless network. Such networks typically contain battery operated devices which require long battery life, low data rate and low duty cycle and have a limited number of nodes talking directly to each other or through an access point or range extenders. Access point and range extenders are not required but provide extra functionality such as store and forward messages. With SimpliciTI, the MCU resource requirements are minimal which results in the low system cost.

SimpliciTI was designed for easy implementation and deployment out-of-the-box on several TI RF platforms such as the MSP430 family of low-power MCUs and the CC1xxx/CC25xx transceivers.

The eZ430-RF2500 demo application uses SimpliciTI to demonstrate a temperature sensor network application that provides a starting point to develop your wireless applications.

NOTE: For the latest SimpliciTI version and more info, please go to www.ti.com/simpliciTI

10. Demo – MSP430 Sensor Monitor

eZ430-RF2500 is preloaded with a wireless temperature sensor network firmware and may be reprogrammed at any time. The included PC visualizer provides a demonstration of the eZ430-RF2500 using SimpliciTI across a star network. In the PC visualizer, the center node is the Access Point and the attached bubbles are the End Devices. The PC application displays the temperature of both the End Devices and Access Point. Additionally, the PC application is capable of simulating distance from its access point when the End Devices are moved. You can also expand the number of End Devices by adding more target boards in the star network as seen in the figure below.

10.1. Demo Hardware Setup

1. Connect the eZ430-RF2500 to a USB port on your PC.
2. Connect the 2nd eZ430-RF2500T target board to the battery board. Insert the jumper on the board to power-up the device.

10.2. Demo Firmware Download

The following details the steps to update the demo application firmware on the eZ430-RF2500 target boards and are not required out-of-the box.

1. Open IAR Workbench Kickstart.
2. Select "**Open Existing Workspace**" and browse for the demo application workspace (*.eww) file. The project is available on the CD or at www.ti.com/ez430-rf.
3. To download demo firmware, follow steps 3a for Access Point firmware and 3b for End Device firmware.

3a. Right click on **Access Point** project in the workspace and click "**Set as Active**" as shown in Figure 3.

3b. Right click on **End Device** project in the workspace and click "**Set as Active**".

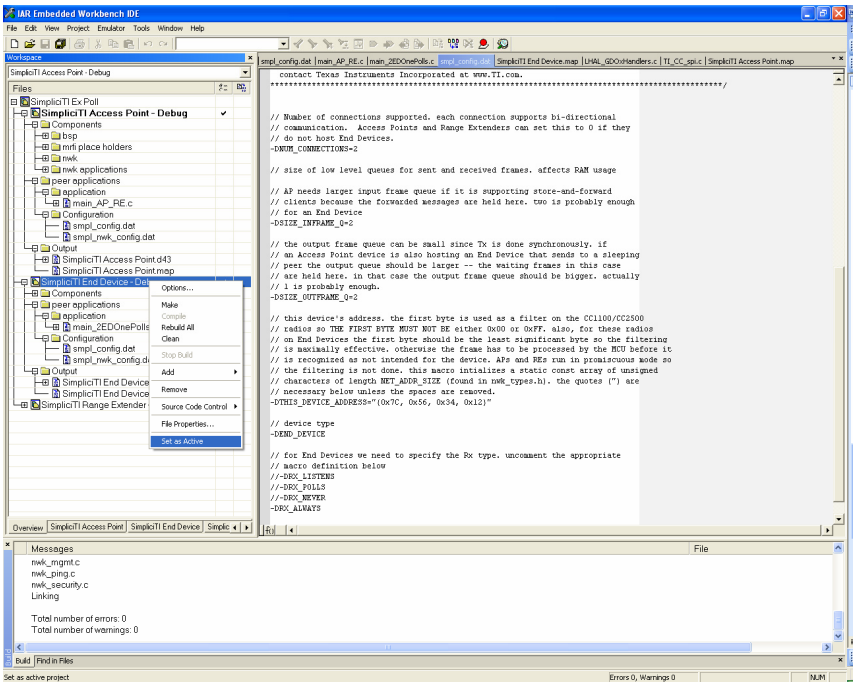


Figure 6. IAR Embedded Workbench Kickstart Workspace

4. Select "**Project**" → "**Debug**" in IAR to download the code for the target boards.
5. Select "**Debug**" → "**Go**" to start running code while in debug mode.
6. Click "**Debug**" → "**Stop Debugging**" exits the debug mode while leaving the target board executing code.

10.3. Demo Software GUI Setup

1. Ensure the Access Point is connected to the PC.
2. Apply power to the End Device.
3. Launch eZ430-RF Temperature Demo PC application (SensorMonitorGUI.exe). It is available on the CD at <CD ROOT>/demo/Demo Visualizer/ or at www.ti.com/ez430-rf.
4. The PC application should automatically display End Devices when in range.

10.4. Demo Options

1. Go to **Menu → Settings**.
2. Under the settings menu, the demo application is capable of displaying values in Celsius or Fahrenheit.
3. Checking the box "**Disable Animations**" disables the dynamic distance change, thus decreasing CPU processing on PC.
4. See the demo application help file by clicking **Help** for more detailed options.

11. Suggested Reading

The primary sources of MSP430 information are the device-specific data sheets and User's Guides. The most up to date versions of the User's Guide documents available at the time of production have been provided on the CD-ROM included with this tool. The most current information is found at www.ti.com/msp430. Information specific to the eZ430-RF2500 development tool can be found at www.ti.com/ez430-rf.

MSP430 device User's Guides and the FET User's Guide may be accessed from the main page on the CD-ROM under the User's Guides section. The FET User's Guide includes detailed information on setting up a project for the MSP430 using IAR.

Documents describing the IAR tools (Workbench/C-SPY, the assembler, the C compiler, the linker, and the library) are located in common\doc and 430\doc. The documents are in PDF-format. Supplements to the documents (i.e., the latest information) are available in HTML-format within the same directories. 430\doc\readme_start.htm provides a convenient starting point for navigating the IAR documentation.

12. Frequently Asked Questions (FAQ)

1) **Does the eZ430-RF2500 support fuse blow?**

   The eZ430-RF USB debugging interface lacks the JTAG security fuse blow capability. To ensure firmware security on devices going to production, the USB Flash Emulation Tool or the Gang Programmer, which include the fuse blow feature are recommended.

2) **What is the voltage supplied to the eZ430-RF2500T target board from the debugging interface?**

   The eZ430-RF USB debugging interface supplies a regulated 3.6V to the eZ430-RF2500T target board.

3) **Can other programming tools interface to the eZ430-RF2500T target board?**

   The eZ430-RF2500T target board will work with any programming tool supporting the 2-wire Spy Bi-Wire interface. Both the MSP430 USB FET (MSP-FET430UIF) and the Gang Programmer (MSP-GANG430) support these devices. See MSP-FET430 Flash Emulation Tool User's Guide (SLAU138) for details on using MSP430 USB FET and the Gang Programmer for a 2-wire Spy-Bi-Wire interface.

4) **What versions of IAR Embedded Workbench and CCE are supported?**

   The eZ430-RF2500 is supported by IAR Embedded Workbench KickStart Release 4.64 (IAR 3.42F) and Code Composer Essentials v2.03 (SP3).

5) **What are the part numbers for the connectors between the eZ430-RF USB debugger and the eZ430-RF2500T target board?**

   - Header: Mill-Max 850-10-006-20-001000
   - Socket: Mill-Max 851-93-006-20-001000

   Mill-Max: http://www.mill-max.com

6) **Where can I obtain more information about the 2.4GHz chip antenna?**

   Part Number: 7488910245

   Würth Electronik Group: www.we-online.com

13. eZ430-RF2500 Schematics

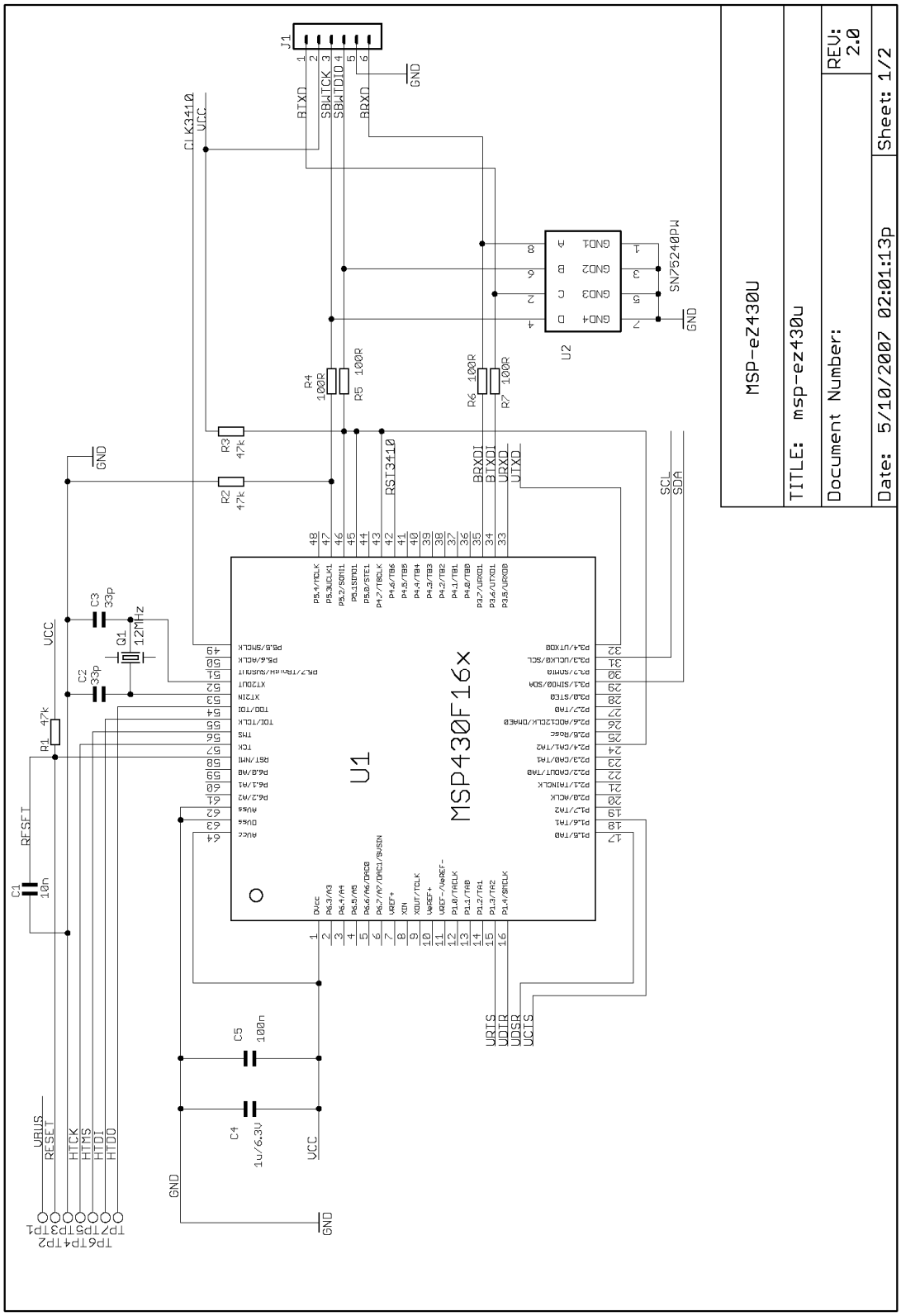


Figure 7. eZ430-RF, USB Debugging Interface, Schematic

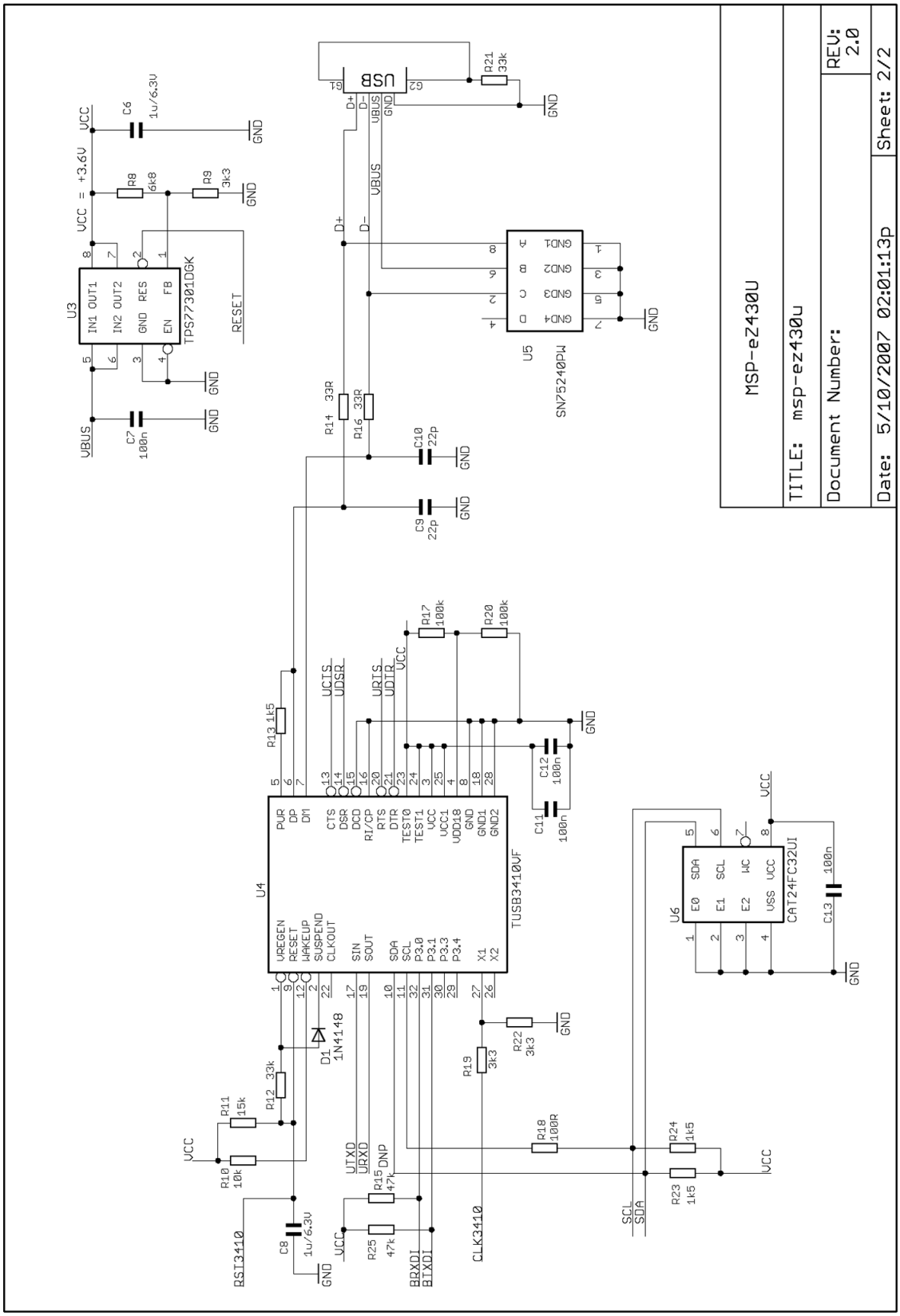


Figure 8. eZ430-RF, USB Debugging Interface, Schematic

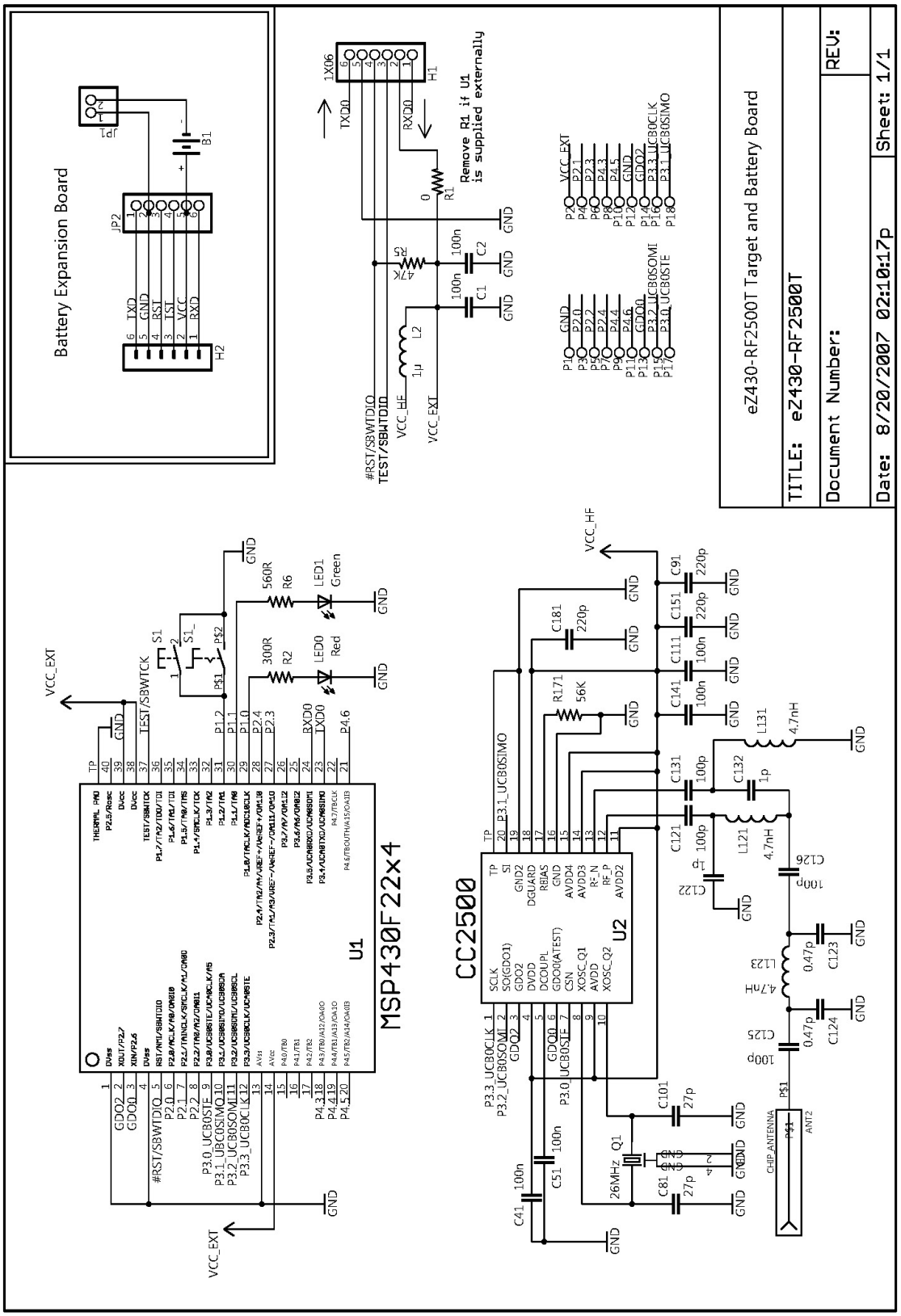


Figure 9. eZ430-RF2500T, Target Board and Battery Board, Schematic

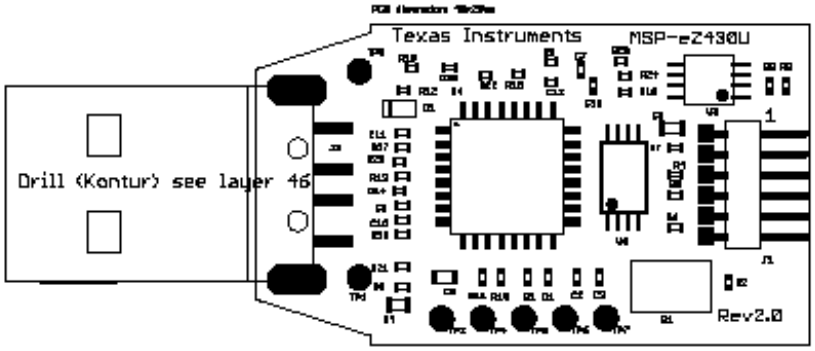
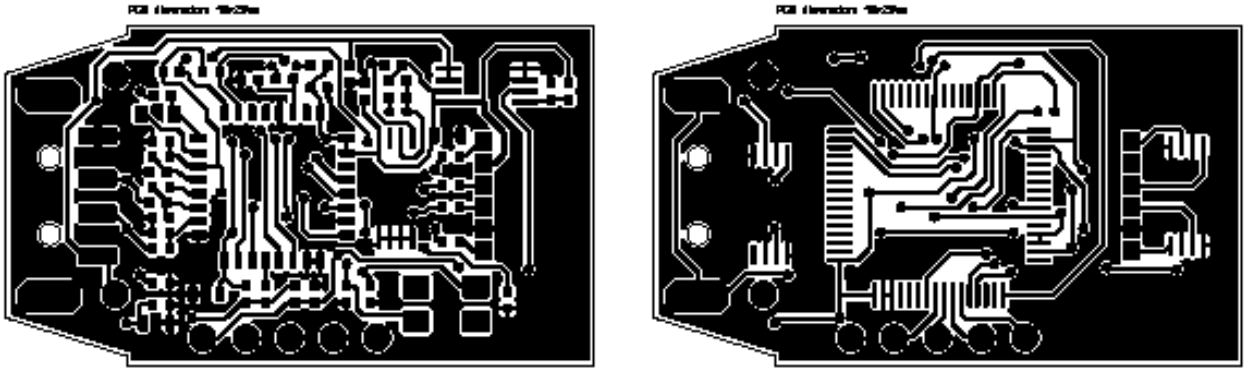


Figure 10. eZ430-RF, USB Debugger, PCB Components Layout



Top Layer

Bottom Layer

Figure 11. eZ430-RF, USB Debugger, PCB Layout

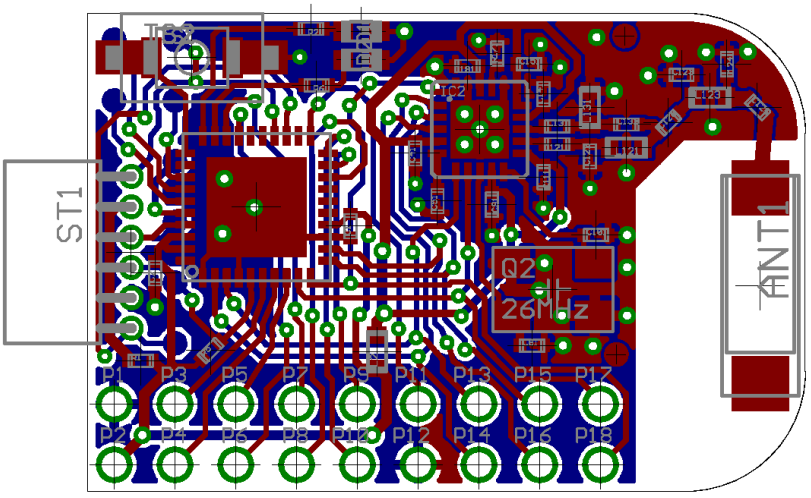


Figure 12. eZ430-RF2500T, Target Board, PCB Layout

14. Detailed Hardware Install Guide

1. Insert the eZ430-RF2500 CD into a CD drive.
2. Install IAR Embedded Workbench KickStart (R4.64 or newer) included on the CD or from www.ti.com/msp430.
3. Insert the eZ430-RF2500 into a USB port of your PC.
4. Windows should recognize the new hardware as **Texas Instruments MSP-FET430UIF** (Figure 13). Windows should automatically install the drivers for the MSP-FET430UIF as a HID tool.

Figure 13. Windows XP Hardware Recognition

5. Windows will recognize another new hardware driver to be installed called **MSP430 Application UART** (Figure 14).

Figure 14. Windows XP Hardware Recognition for MSP430 Application UART

NOTE: This Installation Step is **Optional**. The USB debugging interface will work without the MSP430 Application UART.

6. The “Found New Hardware Wizard” should pop up with a dialog window. Select “**No, not this time**” and click Next (Figure 15).

Found New Hardware Wizard
Welcome to the Found New Hardware Wizard
Windows will search for current and updated software by looking on your computer, on the hardware installation CD, or on the Windows Update Web site (with your permission).
Read our privacy policy
Can Windows connect to Windows Update to search for software?
Yes, this time only
Yes, now and every time I connect a device
No, not this time
Click Next to continue.
< Back
Next >
Cancel

Figure 15. Windows XP Found New Hardware Wizard

7. Select “**Install the software automatically (Recommended)**” (Figure 16). Assuming IAR Kickstart R4.64 or higher has already been installed.

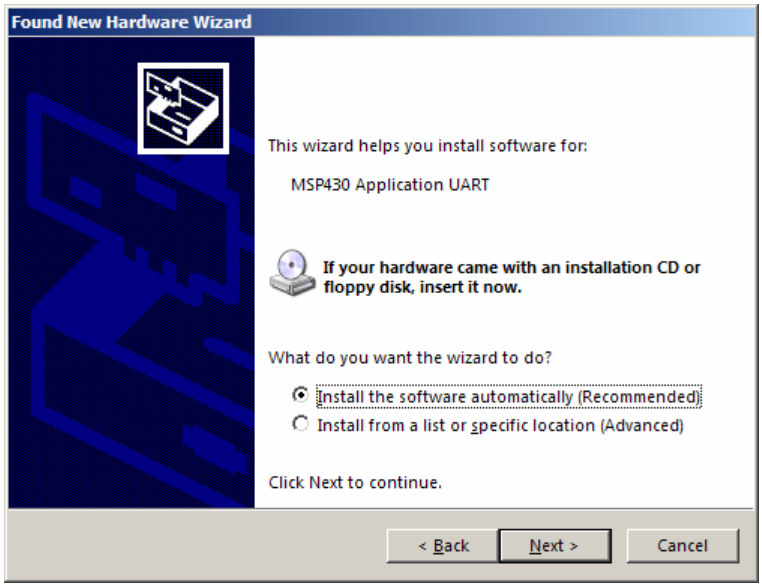

Found New Hardware Wizard
This wizard helps you install software for:
MSP430 Application UART
If your hardware came with an installation CD or floppy disk, insert it now.
What do you want the wizard to do?
Install the software automatically (Recommended)
Install from a list or specific location (Advanced)
Click Next to continue.
< Back
Next >
Cancel

Figure 16. Windows XP Hardware Wizard

8. The Wizard should find the appropriate driver for a Windows XP system; it will prompt you with a warning that Microsoft did not certify the driver. The drivers have been tested exhaustively and you may ignore this warning and click "**Continue Anyway**" (Figure 17).

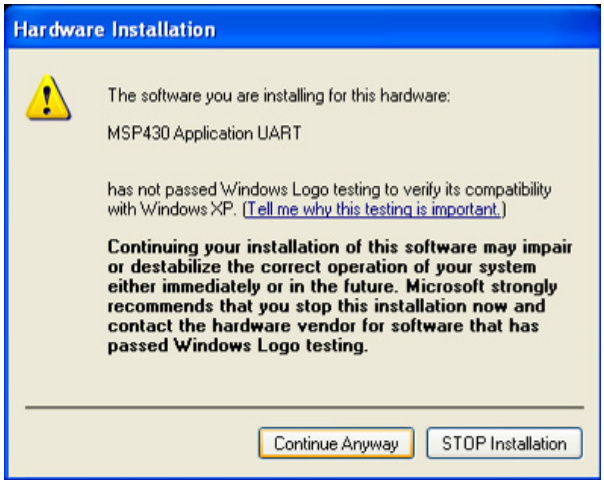

Hardware Installation
The software you are installing for this hardware:
MSP430 Application UART
has not passed Windows Logo testing to verify its compatibility with Windows XP. (Tell me why this testing is important.)
Continuing your installation of this software may impair or destabilize the correct operation of your system either immediately or in the future. Microsoft strongly recommends that you stop this installation now and contact the hardware vendor for software that has passed Windows Logo testing.
Continue Anyway
STOP Installation

Figure 17. Windows XP Warning

9. The Wizard will continue to install the driver and notify you that it has finished the installation of the software.

10. The eZ430-RF2500 is now installed and ready to use. Observe the Device Manager for the assigned COM-port for the MSP430 Application UART as shown in Figure 18.

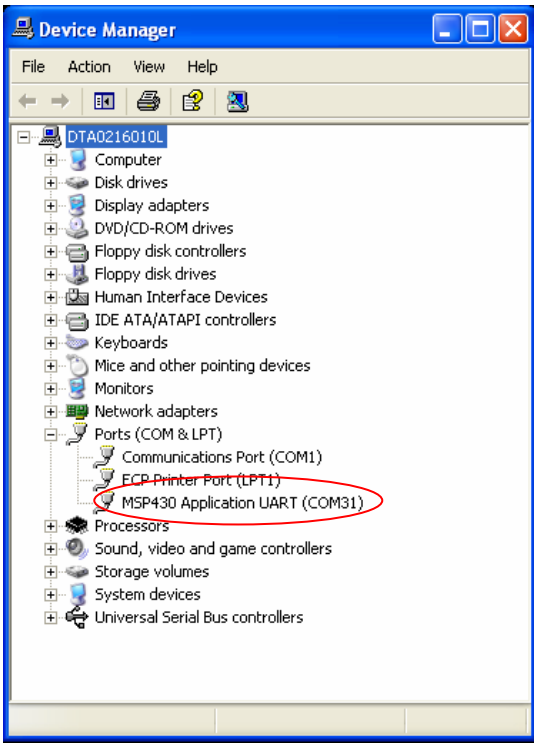


Figure 18. Device Manager